4227

Instruction Manual

Mouth Simulator Type 4227

A sound source designed for use in development and production control of telephone transmitters, microphones and for other applications where a sound field similar to the human voice field is required.

Type 4227 can handle power levels up to 50 W for periods shorter than two seconds, producing a corresponding sound pressure level of 120 dB at a distance of 25 mm from the lip ring.

A constant sound pressure level over the frequency range can be obtained with the aid of a compressor loop arrangement, using a 1/4″ microphone and preamplifier inserted in the mouth opening of the 4227.

A Calibration Jig is supplied for calibration of Type 4227. It is designed to hold a 1/2″ microphone at either 90° or 0° to the mouth axis, in accordance with CCITT P.51 and IEEE 269 standard procedures respectively.

Brüel & Kjær

MOUTH SIMULATOR
TYPE 4227

February 1986

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Mouth Simulator

USES

- Quality control testing of frequency response and distortion of telephone transmitters and close talking microphones
- Sound source for acoustic measurements

FEATURES

- Accurate simulation of human voice field
- Continuous SPL of 110 dB at 25 mm from lip ring
- Low distortion
- Built-in overload protection circuit
- Optional regulating microphone for very accurate frequency response control
- Calibration Jig included
- Conforms to Standards: IEEE 269, 661 and CCITT P.51

Mouth Simulator Type 4227 has been developed for use in the testing of telephone transmitters and other microphones where a sound field similar to the human voice field is required.

Type 4227 produces a minimum continuous output of 110 dB SPL (200 Hz to 4 kHz) at a distance of 25 mm from the lip ring. A sound pressure level of more than 120 dB is possible with pulsed operation. A built-in overload protection circuit minimizes the risk for accidental damage to the loudspeaker.

Provision exists for fitting a 1/4″ microphone at the mouth opening, which can be used in a compressor loop to enable constant sound pressure output.

Accurate calibration is facilitated by a calibration jig provided with the 4227.

B & K Mouth Simulator Type 4227 is a stable, low distortion sound source used for the testing of acoustic transducers. A requirement for the testing of telephone transmitters and close talking microphones is that the sound field should replicate closely the sound field generated by the human mouth, as specified in IEEE 269. Type 4227 fulfills this requirement.

Calibration of 4227 can be carried out with the aid of the Calibration Jig UA 0901 provided. The jig is designed to hold a 1/2″ measuring microphone at a distance of 25 mm from the lip ring (see Fig. 1.). It consists of two interlocking plates which can be fitted together in two ways enabling the microphone to be held with its axis at either 0° or 90° to the mouth axis.

Description

Type 4227 consists of a high quality loudspeaker mounted in a specially shaped housing. A lip ring is mounted on the upper surface of the unit, providing a convenient reference plane for distance measurements.

Fig. 1. Mouth Simulator shown with pressure Microphone Type 4134 in jig for calibration according to CCITT P.51. Free field Microphone Type 4133 can be fitted with zero degree incidence according to IEEE 269

Provision is made in the 4227 for fitting a B&K 1/4″ microphone with 1/4″ preamplifier in the mouth opening to monitor the acoustic output level. The use of such a microphone, e.g. in a compressor loop, is strongly recommended whenever an extremely stable system with a flat frequency response is required without sacrificing ease of operation. The 4227 is delivered fitted with a removable plastic dummy 1/4″ microphone in the mouth opening. This ensures that the Mouth Simulator has the same acoustic characteristics whether a monitoring microphone is installed or not.

Frequency Response

Typical frequency responses without regulation for 10 W continuous and 50 W pulsed operation are shown in Fig. 2. A frequency response with less than ±1 dB deviation over the frequency range (100 Hz to 10 kHz) at 25 mm distance from the lip ring can be easily obtained with the aid of a compressor loop arrangement, using a 1/4″ microphone inserted in the mouth opening of the 4227, and a simple correction network (see Fig. 2.).

The 4227 is delivered with a calibration chart giving the frequency response measured at a distance of 25 mm from the lip ring. Detailed operating characteristics, including fre-

quency response relationships are given in the 4227 Instruction Manual.

Output SPL

Type 4227 can produce a minimum SPL of 110 dB in the frequency range 200 Hz to 4 kHz and 100 dB in the range 100 Hz to 8 kHz, at a distance of 25 mm from the lip ring. This is achieved with the maximum continuous power consumption of 10 W.

The Mouth Simulator can be operated at higher power levels for short periods. Power levels of up to 50 W can be safely used for periods of less than two seconds (20 seconds intervals), producing a corresponding output SPL of 120 dB at a distance of 25 mm from the lip ring.

Applications

Testing of telephone handsets is facilitated with Telephone Test Head Type 4905. This permits the accurate mounting of the handset relative to the 4227 and also has provision for holding various types of artificial ear assemblies.

Accurate automated quality control checks of audio communication transducers can be carried out using Transducer Test System Type 9573 (Fig. 3). The 4227 is also used in the Type 3356 and 3357 Electroacoustic Telephone Transmission Measuring Systems. Further information can be found in the literature for the respective systems.

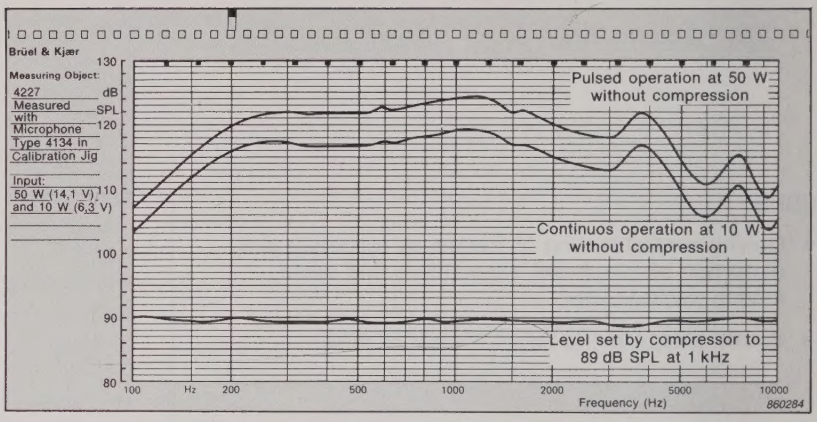


Fig. 2. 4227 frequency response at 25 mm distance at 10 and 50 W without compression and frequency response with equalization in compressor loop

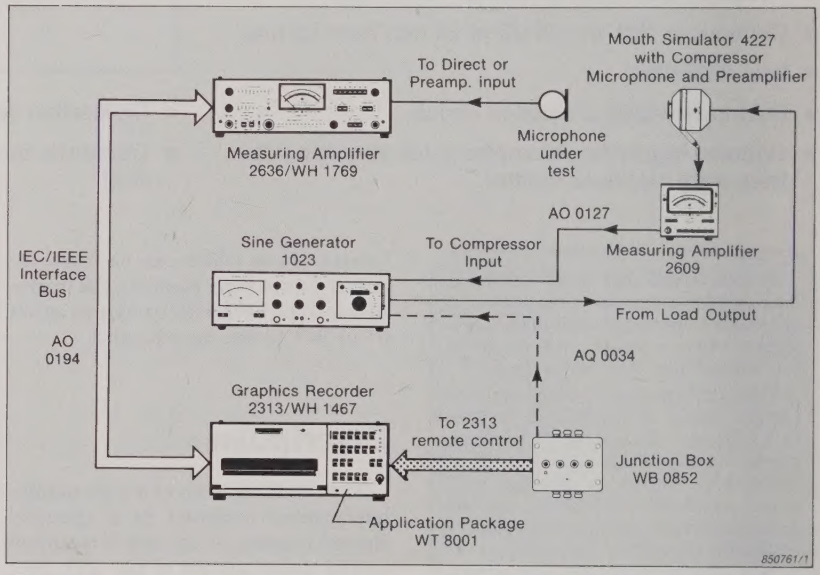


Fig. 3. Microphone tests using Transducer Test System 9573 with Mouth Simulator and compressor loop facility

Specifications 4227

CONTINUOUS OUTPUT LEVEL:
Min. 110 dB SPL, 200 Hz to 4 kHz
Min. 100 dB SPL, 100 Hz to 8 kHz
Measured 25 mm from lip ring.
See graph above for SPL range.

DISTORTION:
at 94 dB SPL, 25 mm from lip ring
200 Hz to 315 Hz: <2%
315 Hz to 8 kHz: <1%

LOUDSPEAKER:
Max. average power: 10 W at 20° C (68° F)
Max. pulsed power: 50 W for 2 seconds (limited by protection circuit)
Impedance: 4 Ω
Diameter: 88 mm (3,5 in)

MOUTH OPENING:
Diameter: 20 mm (0,8 in)

LIP RING:
Position: 10 mm (0,4 in) from mouthpiece
Outer diameter: 48 mm (1,9 in)

DIMENSIONS:
Height: 104 mm (4,1 in) to top of lip ring
Diameter: 104 mm (4,1 in)

WEIGHT:
2,2 kg (4,8 lbs)

ACCESSORIES INCLUDED:
Calibration Jig ..... UA 0901
2 × Lip Ring ..... SO 0005
1/4″ Plastic Microphone Dummy ..... DA 0150

ACCESSORIES AVAILABLE:
1/4″ Condenser Microphone for monitoring acoustic output level ..... 4136 or 4135
Preamplifier for 1/4″ microphone cartridges 2633
1/2″ Condenser Microphone for calibration ..... 4133 or 4134
Preamplifier for 1/2″ microphone cartridges 2639
Mouthpiece with lip ring (for simulating sound field of earlier Type 4219) ..... UA 0899

2. OPERATION

2.1. GENERAL (RECORDING THE FREQUENCY RESPONSE OF MICROPHONES)

When measuring the frequency response of microphones, the frequency response of the Mouth Simulator should also be taken into consideration. This can be dealt with in 3 general ways:

1. By use of a compressor loop to make the output frequency response flat. A compressor loop uses a microphone mounted inside the Mouth Simulator to monitor the SPL output and automatically regulate the output of the signal generator accordingly. The advantages of using a compressor loop are a higher degree of stability with time, atmospheric pressure changes, and temperature changes, and that the SPL can be easily adjusted in calibrated steps.

   Measurements of the frequency response of microphones using a compressor loop facility can be carried out with the set-up shown in Fig. 2.1. The arrangement is similar to that of Fig. 2.3, but with the addition of Level Recorder Type 2307 (or X-Y Recorder Type 2308). Alternatively, the Sine Generator and the Measuring Amplifier used in the compressor loop can be replaced by a Heterodyne Analyzer Type 2010 and a Power Amplifier Type 2706 if convenient, or the Transducer Test System Type 9573 can be used.

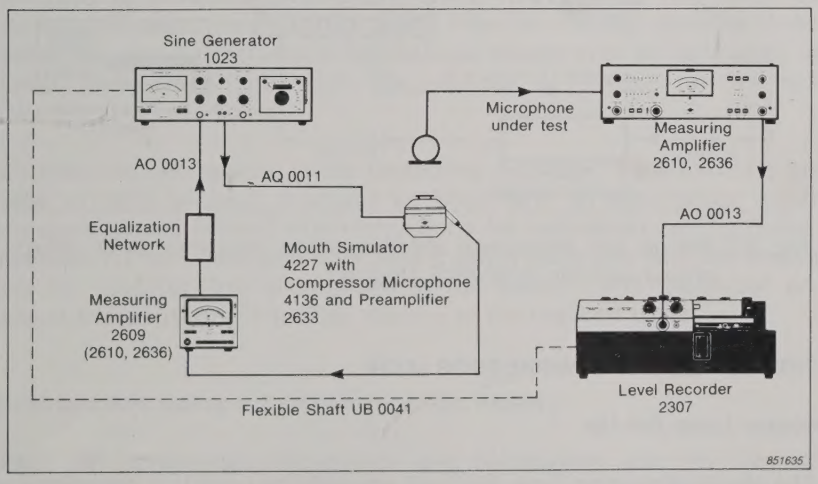


Fig. 2.1. Typical measuring set-up for automatic recording of the frequency response of a microphone

Before starting measurements on the microphone to be tested, it is important to adjust for a constant sound pressure output as described in Section 2.2 and record the output level on the Level Recorder to check that it is constant at all frequencies over the frequency range of interest.

2. A programmable signal generator can be used. The input signal to the 4227 can then be shaped to allow for the frequency response of the 4227 and for the attenuation at the test microphone, which depends on the operating frequency and distance from the source. A constant SPL at the test position can then be produced.

3. Post-processing of the microphone response can be employed to correct for the output SPL of the 4227 as a function of frequency at the particular distance from the lip ring at which the microphone is being tested. This is easily accomplished when making measurements using the Two Channel FFT Analyzer Type 2032 or 2034 in the "equalized mode".

   The response of the 4227 is first measured using a reference microphone with a "flat" frequency response, positioned where the microphone to be tested is placed. Use of the "equalized" mode of the Analyzer subtracts the resulting response from the measurements on the test microphone. An advantage of this method is that the disturbance of the sound field often caused by the microphone is avoided. A measurement set-up for measuring the frequency response of a microphone with Analyzer Type 2032 is shown in Fig. 2.2.

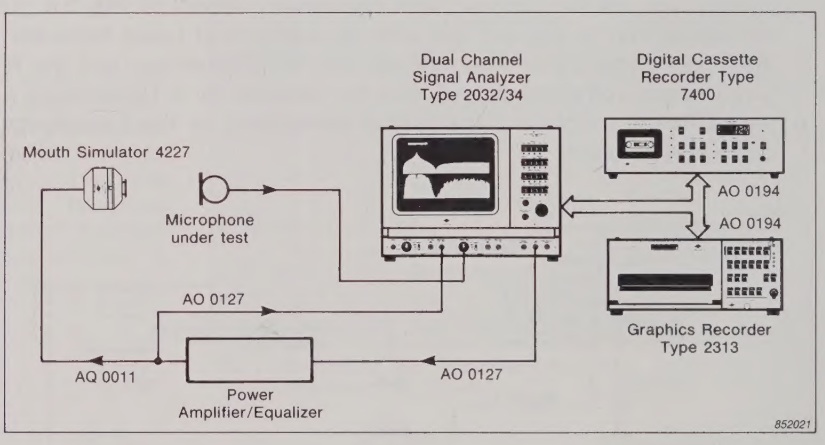


Fig. 2.2. Set-up for measuring the frequency response of a microphone with the 2032 FFT Analyzer

2.2. SETTING UP THE 4227 WITH A COMPRESSOR LOOP

2.2.1. Basic Compressor Loop Set-Up

The Mouth Simulator Type 4227 will normally be used in a measuring set-up where a flat frequency response is required, e.g. for testing telephone transducers and individual microphones. A flat frequency response can be obtained with the aid of a compressor loop arrangement using a 1/4″ Microphone, such as B & K Type 4136 or 4135 with a Preamplifier Type 2633, inserted in the mouth opening of the 4227 to operate the compressor facility of a sine or narrowband noise generator capable of driving the 4227 (4 Ω).

The loudspeaker in the Mouth Simulator is supplied from a generator with compressor facility (e.g. Sine Generator Type 1023), and a measuring amplifier (e.g. Measuring Amplifier Type 2609) is used to amplify the feedback signal to the compressor in the generator.

A basic instrument set-up using the compressor loop facility of Sine Generator Type 1023 is shown in Fig. 2.3.

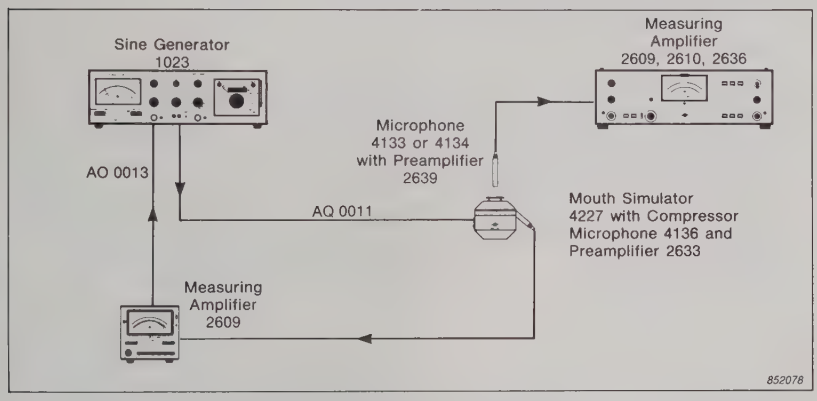


Fig. 2.3. Basic compressor loop arrangement

2.2.2. Calibration of Reference Microphone

For precise determination of the sound pressure level produced by the 4227, a 1/2″ reference Microphone Type 4133 or 4134 can be mounted at the position where test microphones are to be measured. For this purpose the reference Microphone can be mounted at a reference position 25 mm from the lip ring using the Calibration Jig UA 0901 supplied (see Section 2.3.1). Prior to making measurements using the Mouth Simulator, the 1/2″ reference Microphone should first be calibrated using either Sound Level Calibrator Type 4230 (94 ±0,3 dB at 1 kHz) or Pistonphone Type 4220 (124 ±0,15 dB at 250 Hz).

Connect the Microphone to the Measuring Amplifier. If a Measuring Amplifier Type 2609, 2610 or 2636 is used, it should be fitted with an appropriate meter scale for sound pressure measurements. Full instructions for calibration can be found in the Instruction Manuals for the Pistonphone or Sound Level Calibrator and the Measuring Amplifier. Fit the 1/2″ adaptor and Microphone to the Sound Level Calibrator or Pistonphone and adjust the Measuring Amplifier reading to the required value.

2.2.3. Setting Up Constant SPL using a Compressor Loop Facility

Fit a 1/4″ compressor Microphone and Preamplifier into the channel provided by unscrewing the removable upper housing of the 4227 and taking out the plastic dummy microphone which should be retained for refitting when the 1/4″ Microphone is no longer required. The acoustic properties of the Mouth Simulator are thus not changed by the insertion of the Microphone.

The procedure is:

1. Calibrate the reference Microphone as described in Section 2.2.2.

2. Connect the instruments as shown in Fig. 2.3. Wait approximately 5 seconds for them to stabilize after switching them on.

3. On the Generator (1023) set:

OUTPUT VOLTAGE	"0"
POWER	"On"

Generator operation controls:

REF. SIGNAL	"On"
GENERATOR	"On"
SWEEP CONTROL	Not applicable in ref. mode

Frequency and related controls:

MODULATION FREQUENCY	"Mod Off"
COUNTING TIME	Not applicable in ref. mode
FREQUENCY DIAL	Must be within scale

Compressor controls:

COMPRESSOR SPEED	"300 dB/s"
COMPRESSOR VOLTAGE	"10"

Output controls:

OUTPUT ATTENUATOR	"Load"

4. On the Measuring Amplifier (2609) set the following controls:

POWER	"On"
METER DAMPING	"Fast"
REFERENCE	"Off"
WEIGHTING FILTER	"Off"
RANGE I	"0 (dB)"
RANGE II	"30 (mV)" (or adjust to expected voltage)

5. On the Generator slowly turn the OUTPUT VOLTAGE control fully clockwise observing the meter on the 2609 which should read between 1 and 2 at the low end of the upper scale. Notice that the reading is independent of attenuator and meter sensitivity settings — if the equalization network in Section 2.3.2 is used the reading will be approximately doubled)

6. Monitor the sound pressure level at the output of the 4227 using the calibrated reference Microphone and Measuring Amplifier combination. The output sound pressure level can now be increased by turning the COMPRESSOR VOLTAGE anticlockwise (decreasing the degree of compression). Alternatively it can be altered in calibrated steps by using the attenuator on the 2609 Measuring Amplifier in the compressor loop or by adjusting the sensitivity potentiometer of the Measuring Amplifier for fine adjustment of the SPL.

The procedure described above explains how to adjust the Mouth Simulator to give a constant SPL when driving it from the output of the 1023 Sine Generator. Higher SPL's can be obtained by using a power amplifier; see Fig. 3.3 in Section 3.2.1 for actual SPL's.

To check that a constant SPL is generated over the particular frequency range of interest, monitor the output of the 4227 with the reference Microphone, while manually tuning the generator frequency. Alternatively record the output of the 4227 using a level or X-Y recorder (see Fig. 2.1). For automatic recording with the B&K Level or X-Y Recorder Types 2307 and 2308, their respective instruction manuals should be consulted.

Although the SPL at the orifice can be kept constant using this technique, the SPL will vary slightly with frequency at positions beyond the lip ring. Often it is desired to maintain a constant output level with frequency at the reference position 25 mm in front of the centre of the lip-plane; information about this can be found in Section 2.3.

When a microphone under test is placed in front of the Mouth Simulator it will cause a change in the output SPL if no compression is used. This *obstacle effect* which is a function of frequency and distance from the lip ring is described in Section 3.2.4. It is automatically compensated for when the 4227 is being operated at constant SPL using a compressor loop.

2.3. EQUALIZATION

2.3.1. Calibration at Ref. Position

For certain measurements on telephone equipment in accordance with the IEEE 269, 661 and CCITT P.51 standards, it is recommended that test objects are mounted in a reference position 25 mm in front of the lip ring. The output sound pressure level of the 4227 can be measured at this position using a 1/2″ reference Microphone mounted in the Calibration Jig supplied. Prior to measuring the frequency response from the Mouth Simulator, the 1/2″ Microphone should first be calibrated using either Sound Level Calibrator Type 4230 or Pistonphone Type 4220 as described in Section 2.2.2.

The Calibration Jig enables the reference Microphone to be mounted exactly 25 mm in front of the lip ring which serves as the reference plane for all distance measurements. The Jig consists of two plates which interlock in two configurations, one for vertical mounting (microphone coaxial to the mouth axis) and the other for horizontal mounting (microphone perpendicular to the mouth axis), as shown in Figs. 2.4 and 2.5. Use of a 1/2″ free-field Microphone (Type 4133) or a 1/2″ pressure Microphone (Type 4134), depends on the national standard (IEEE 269 or CCITT P.51) to which the measurement must conform.

A 1/2″ pressure Microphone can be used in the coaxial position if free-field correction is applied. All measurements in this manual using the Calibration Jig are made with microphones positioned as illustrated in Figs. 2.4 and 2.5.

Frequency responses measured with 1/2″ free-field or pressure Microphone Type 4133 and 4134 fitted in the Calibration Jig are illustrated in Figs. 2.6(a) and (b). The intention of both calibration techniques is to make a true free-field calibration of the Mouth Simulator. The reference for both measurements is the response measured with a 1/4″ Microphone Type 4135 freely suspended measured at 25 mm distance. This is assumed to equal the true free-field response. It can be seen that a coaxially mounted 4133 Microphone gives a small, but frequency independent, overestimation of $\approx$ 0,6 dB. A perpendicularly mounted 4134 Microphone gives an underestimation of only $\approx$ 0,1 dB, but overestimates the response between 4 kHz and 8 kHz.

Fig. 2.4. Fitting of Jig when using 1/2″ free-field Microphone (e.g. 4133)

Fig. 2.5. Fitting of Jig when using 1/2″ pressure Microphone (e.g. 4134)

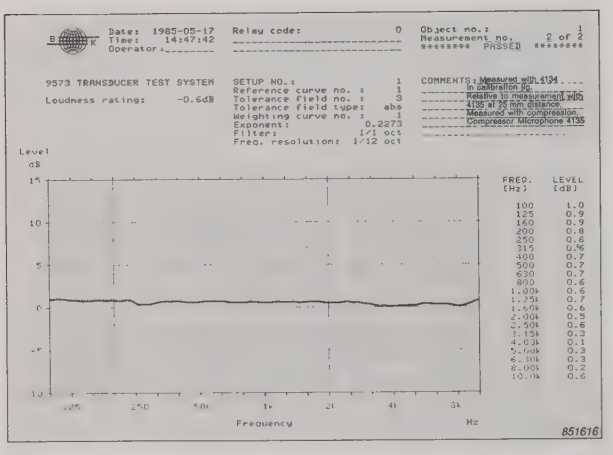


Fig. 2.6(a). Frequency response with 1/2″ free-field Microphone Type 4133 in Calibration Jig, relative to measurement with 1/4″ Microphone Type 4135

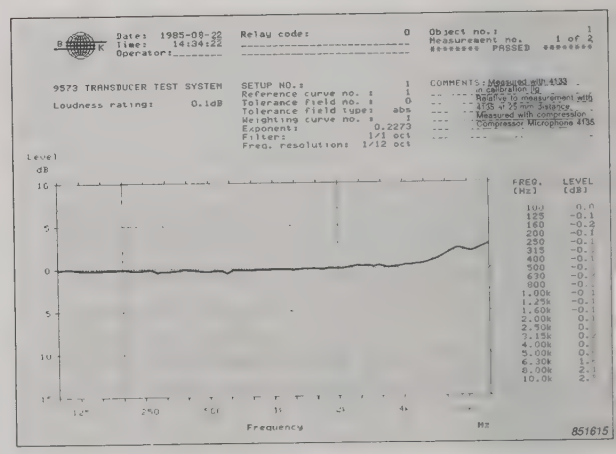
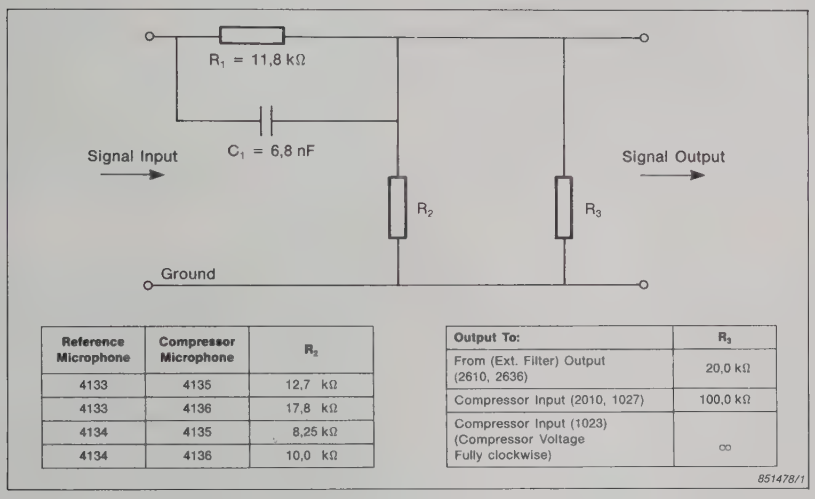


Fig. 2.6(b). Frequency response with 1/2″ pressure Microphone Type 4134 in Calibration Jig, relative to measurement with 1/4″ Microphone Type 4135

2.3.2. Equalization Network

A very flat frequency response (±1 dB deviation in SPL, 100 Hz to 10 000 Hz) can be obtained in the reference position, if a simple equalization network (see Fig. 2.7) is inserted in the compressor loop between the Measuring Amplifier and the compressor Generator.



Reference Microphone	Compressor Microphone	R_2
4133	4135	12,7 kΩ
4133	4136	17,8 kΩ
4134	4135	8,25 kΩ
4134	4136	10,0 kΩ

Output To:	R_3
From (Ext. Filter) Output (2610, 2636)	20,0 kΩ
Compressor Input (2010, 1027)	100,0 kΩ
Compressor Input (1023) (Compressor Voltage Fully clockwise)	∞

Fig. 2.7. Equalization network for use with combinations of measurement Microphones Types 4133, 4134 and compressor Microphones Types 4135, 4136

In the table shown in Fig. 2.7, optimum values of R_2 are given for the four possible combinations of compressor (4135 or 4136) and reference (4133 or 4134) Microphone. R_3 should be chosen in accordance with the second table, i.e. depending on the loading of the equalization network. The effect of this equalization is shown in Fig. 2.8; the sound pressure at the reference position (measured in Jig) is shown for each of the four combinations, with and without the equalization network inserted in the compressor loop. A switchable equalizer network is available from B&K on special order as accessory WB 1000.

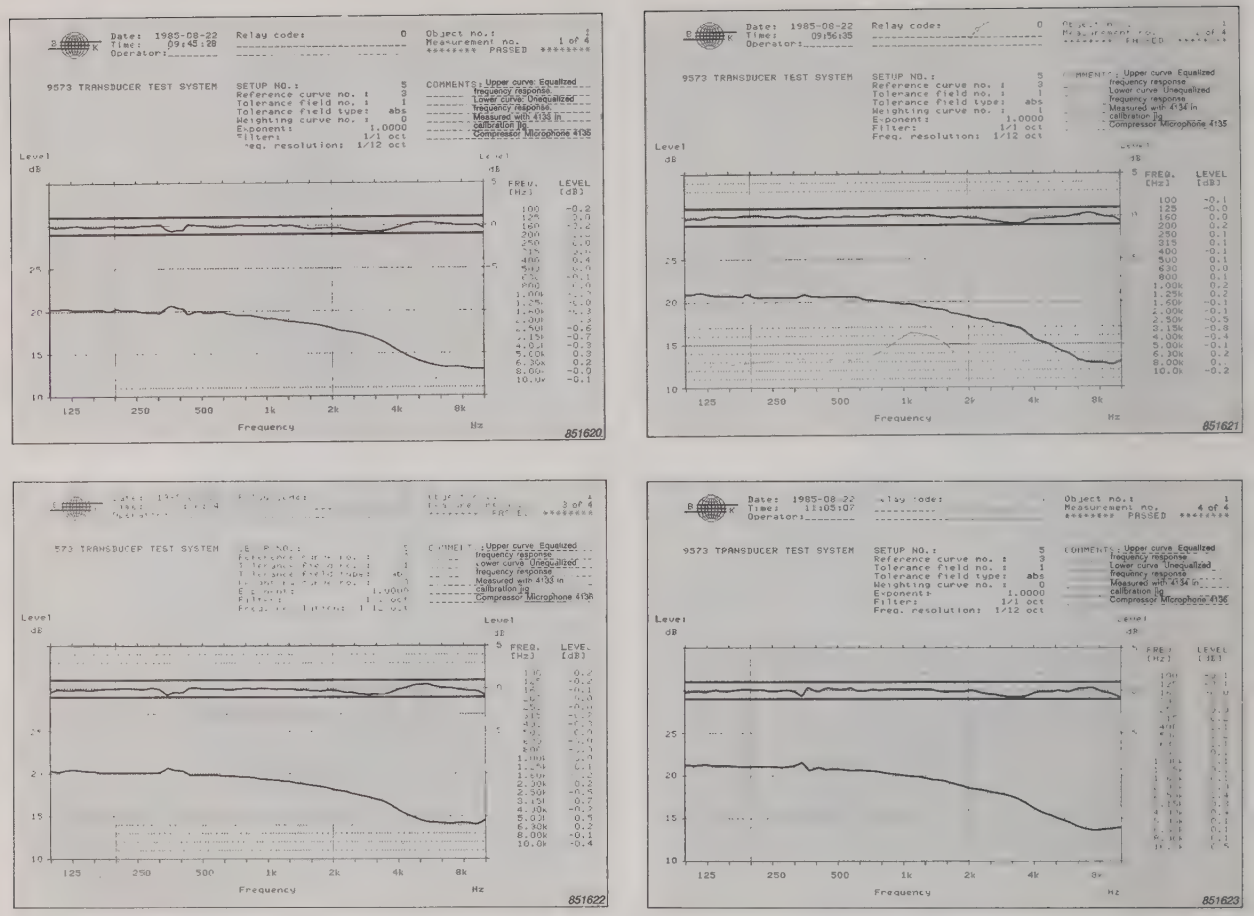


Fig. 2.8. Unequalized (lower curve) and equalized (upper curve) frequency responses for the four combinations of compressor and reference Microphones. Upper curves are measured with the reference Microphone in Calibration Jig. Lower curves are measured with a 1/4″ Microphone in the compressor microphone position relative to the reference Microphone in the Calibration Jig

2.4. USE OF THE 4227 WITH THE TRANSDUCER TEST SYSTEM TYPE 9573

The 4227 Mouth Simulator is particularly well suited for use with the Transducer Test System 9573, where it will usually be used with the Telephone Test Head Type 4905. A typical instrument set-up is shown in Fig. 2.9.

For maintaining a constant output from the 4227 and to obtain very accurate measurements, even with relatively long intervals between calibration, the compressor function of the 1023 Sine Generator and the equalization network described in Section 2.3.2 are used. Alternatively a programmable generator or postprocessing can be employed. See section 2.1.

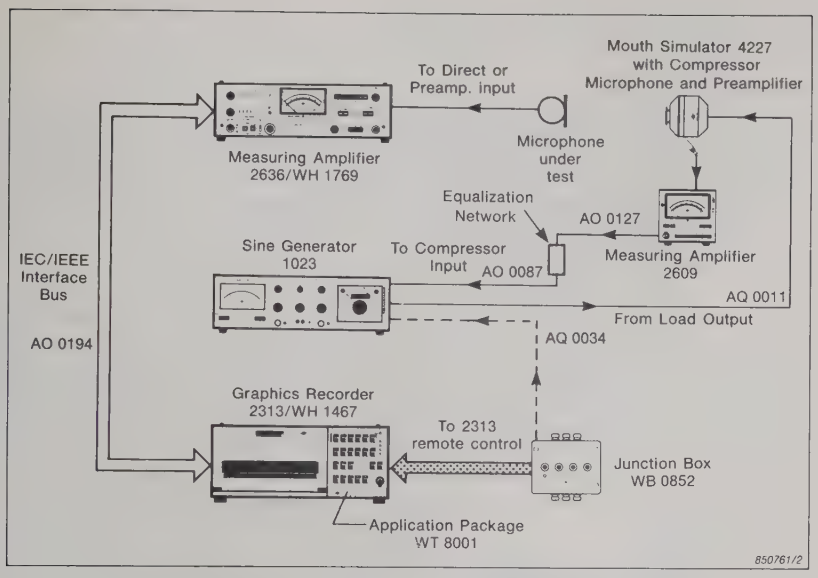


Fig. 2.9. Transducer Test System Type 9573

The following procedure should be used if the Mouth Simulator is to simulate a high impedance (constant volume velocity) source. If a low impedance (constant pressure) source is desired, the same procedure is followed, omitting items 2 and 3. See Section 3.2.4.

1. Mount a reference Microphone in the Calibration Jig and insert an appropriate equalization network (see Section 2.3.2) in the compressor loop. Adjust the gain of the compressor loop to set the output of the Mouth Simulator as desired at one particular frequency (e.g. 1000 Hz or 250 Hz).

   Then measure the frequency response of the 4227 with the ref. Microphone using the same set-up. Store this measurement as a reference for the following measurement.

2. With the set-up described in item 1, make a measurement of the input voltage to the 4227 by connecting the input sockets of the 4227 to the direct input of the Measuring Amplifier. Store the result of this relative measurement as a reference for the next measurement.

3. Replace the reference Microphone and Jig with the microphone (or telephone handset) to be tested. Repeat the measurement of the input voltage to the 4227 and once more store the result as a reference for the following measurements. This is the same measurement as in item 2 but includes the obstacle effect caused by the measuring object. Storing the measurement in item 2 and using it as a reference for the measurement in item 3 adds the obstacle effect to the measurement made in item 1.

4. The system is now calibrated and ready for testing the microphones, the output of which is connected to the input of the test system.

2.5. USE OF THE TELEPHONE TEST HEAD TYPE 4905

In addition to general use for recording the frequency response of individual microphones, the Mouth Simulator Type 4227 is designed to be used with the Telephone Test Head Type 4905. This Test Head has been designed to permit accurate and reproducible mounting of complete telephone handsets relative to the Mouth Simulator and to various artificial ear assemblies; it grips handsets accurately in the standardized positions used by the telephone industry; the REF and AEN modal positions, as well as the Loudness Rating Guard Ring Position (LRGRP).

When measuring on certain handsets the lip ring can be an obstruction. Removing the lip ring will change the acoustic characteristics of the Mouth Simulator slightly, because the holes for mounting the lip ring are exposed. Instead of removing the lip ring it is recommended to use the extra lip ring supplied and using an appropriate tool adapt it by removing the part that runs against the handset.

Fig. 2.10. Mouth Simulator 4227 mounted in the Telephone Test Head Type 4905

3. OPERATING CHARACTERISTICS

3.1. CONSTRUCTION

A sectional view of the Mouth Simulator Type 4227 is shown in Fig. 3.1. It consists of a small dynamic loudspeaker of 88 mm diameter mounted in a rigid aluminium housing. The impedance of the loudspeaker is 4 ohm and it has a maximum power rating for continuous operation of 10 W. For generating SPL's in excess of 120 dB drive levels of up to 50 W can be applied for periods of less than 2 s. A pair of sockets accepting standard 4 mm banana plugs for connection of the drive source is provided on the side of the housing. The positive socket or terminal (a positive pulse makes the cone moving outwards) is marked with a white dot.

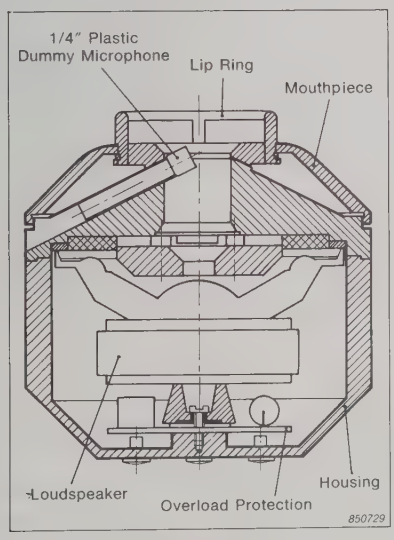


Fig. 3.1. Sectional view of Mouth Simulator Type 4227

A removable mouthpiece is located in front of the loudspeaker and has a circular opening of 20 mm diameter. Provision is made for the installation of a 1/4" compressor Microphone, with the diaphragm located slightly off-centre in the orifice. When a 1/4" Microphone is not installed in the 4227, the plastic dummy microphone should be left in the microphone mounting channel to maintain acoustic equivalence.

A lip ring is mounted on the mouthpiece and positioned 10 mm above the surface of the mouthpiece. The outside diameter of the lip ring is 48 mm. The surface of the lip ring serves as a reference plane for measurements at various distances from the Mouth Simulator. The pressure drop with distance from the plane of the lip ring is similar to that of a human source. The lip ring is snapped in place and can be easily removed to allow mounting of the extra lip ring. The mounting plate is drilled and tapped with 3/8"

thread and has four locating holes on its flat surface. These locating holes facilitate mounting on the Telephone Test Head Type 4905.

To protect the 4227 from accidental overload, an overload protection circuit is built in. This circuit automatically disconnects the loudspeaker before overheating takes place (see Section 3.5).

3.2. FREE FIELD CHARACTERISTICS

3.2.1. Frequency Response

The free-field frequency response curves of the Mouth Simulator were measured using the Transducer Test System Type 9573 as shown in Fig. 3.2. The drive voltage applied to the 4227 was monitored directly at the 4227 input sockets.

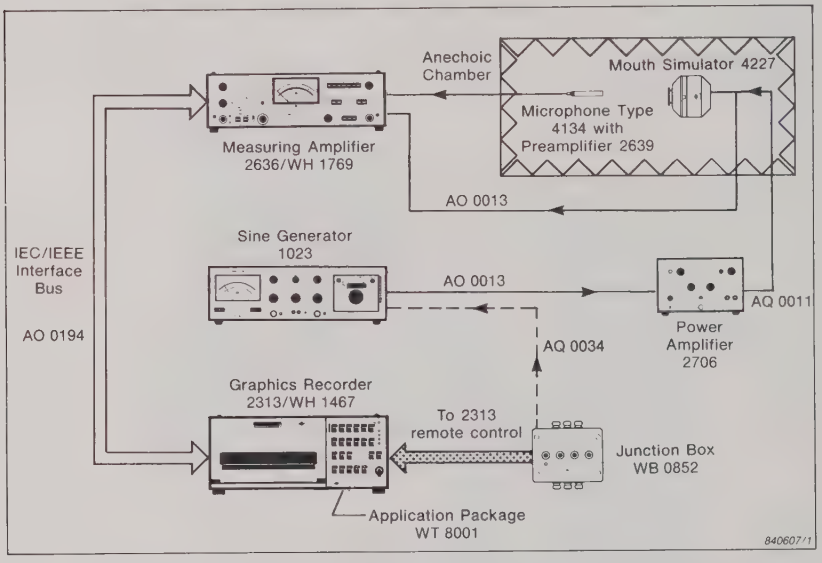


Fig. 3.2. Measuring arrangement for measuring the free-field frequency response of the Mouth Simulator

The frequency response curves at different input levels (Fig. 3.3) were measured at a distance of 25 mm from the lip ring, using a 1/2″ pressure Microphone Type 4134 fitted in the Jig provided (UA 0901). The curves were measured without compression at 0,1 W (0,63 V), 1 W (2 V), 10 W (6,3 V) continuous operation and 50 W (14,1 V) pulsed operation.

For a specified input the obtainable frequency range with compression can be found by drawing a horizontal line at the particular SPL required and noting where it intersects the curve.

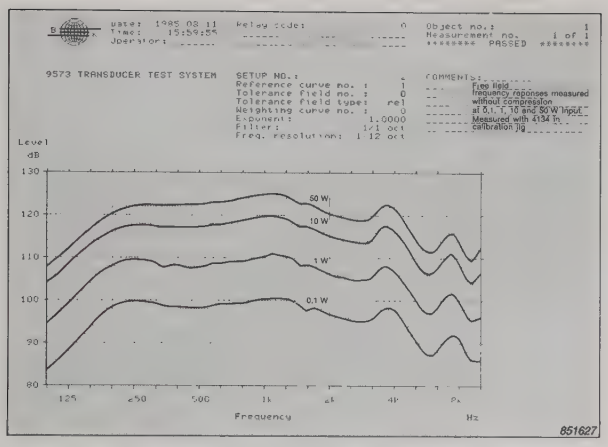


Fig. 3.3. Frequency response of the 4227 at different input levels

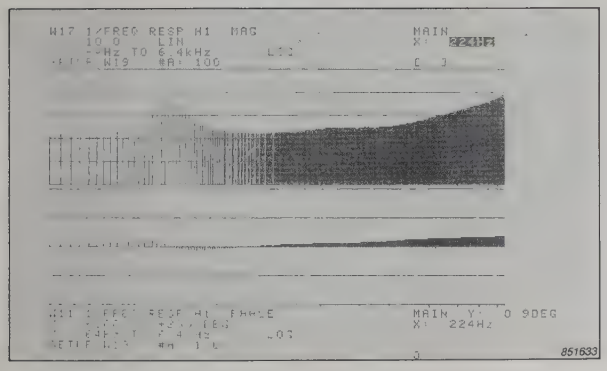


Fig. 3.4. Impedance curve for the 4227

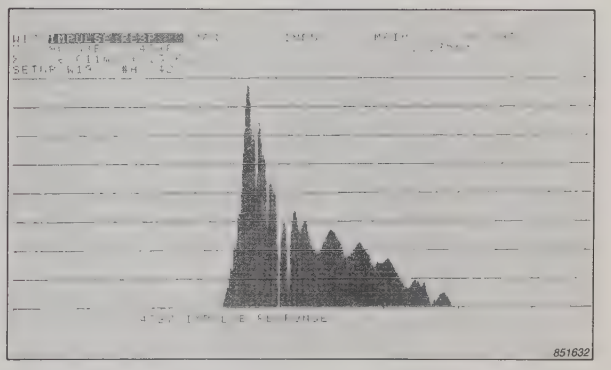


Fig. 3.5. Impulse response of the 4227

3.2.2. Sound Pressure Variation with Distance

Although the sound pressure level produced by the 4227 can be held constant at the compressor microphone position, it will vary with distance and frequency.

In the standardized IEEE/CCITT reference position 25 mm from the lip ring, these deviations can be compensated for by using the equalization network shown in Section 2.3.2 to obtain a frequency response which is flat within ±1 dB (100 Hz to 10 kHz).

Other positions of special interest when measuring the frequency response of telephone handsets and microphones are:

1. Modal position for boom-tube headset microphones — measurement position 6 mm behind plane of the lip ring and 42 mm off-axis (referred to as the "–6/42 mm" position).

2. Nosfer ref. position — measurement position 140 mm in front of lip ring plane, on-axis.

3. Free-field ref. position — measurement position 500 mm in front of lip ring plane, on-axis.

Sound pressure level measurements at these positions were made with the measuring set-up shown in Fig. 3.6 and are illustrated in Fig. 3.7. All measurements are relative to the sound pressure level at the 25 mm reference position.

Frequency responses for ANSI/IEEE 661 positions (10, 20, 40, 25/20 and 25/40 mm) are all well within the specified tolerance fields.

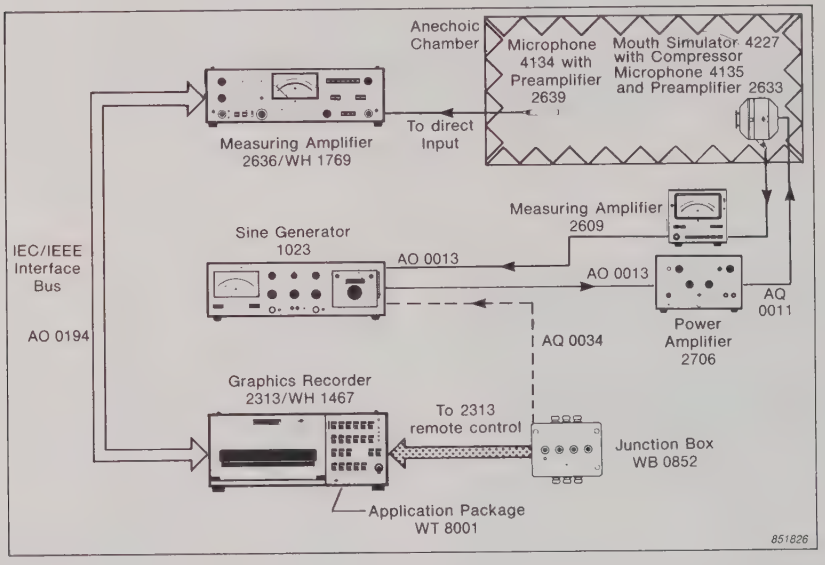


Fig. 3.6. Measuring arrangement used for recording the free-field frequency responses of the Mouth Simulator at different distances from the lip ring

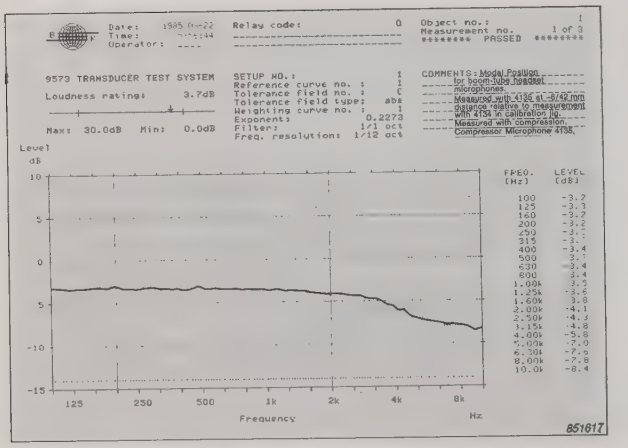


Fig. 3.7(a). SPL measurement at modal position for boom-tube headset microphones — 6 mm behind lip ring plane and 42 mm off-axis

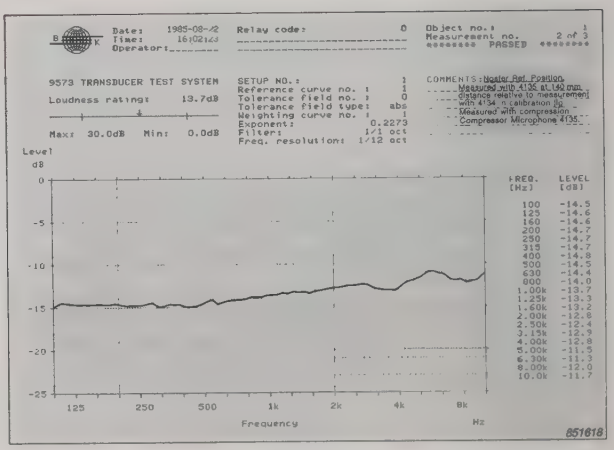


Fig. 3.7(b). SPL measurement at nosfer ref. position — 140 mm from lip ring plane on-axis

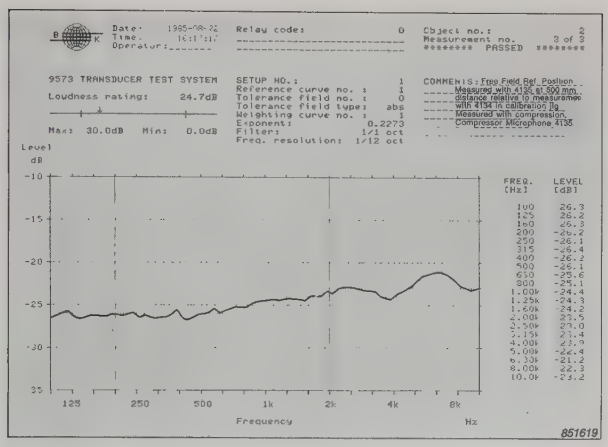


Fig. 3.7(c). SPL measurement at free-field ref. position — 500 mm from lip ring plane on-axis

3.2.3. Harmonic Distortion

Harmonic distortion of the Mouth Simulator was measured using the instrument arrangement shown in Fig. 3.8 which includes a Heterodyne Analyzer Type 2010 for swept frequency distortion measurements. Both the second and third harmonic distortion were measured with compression at 3 different sound pressure levels: 94, 104 and 114 dB SPL. The results are shown in Fig. 3.9.

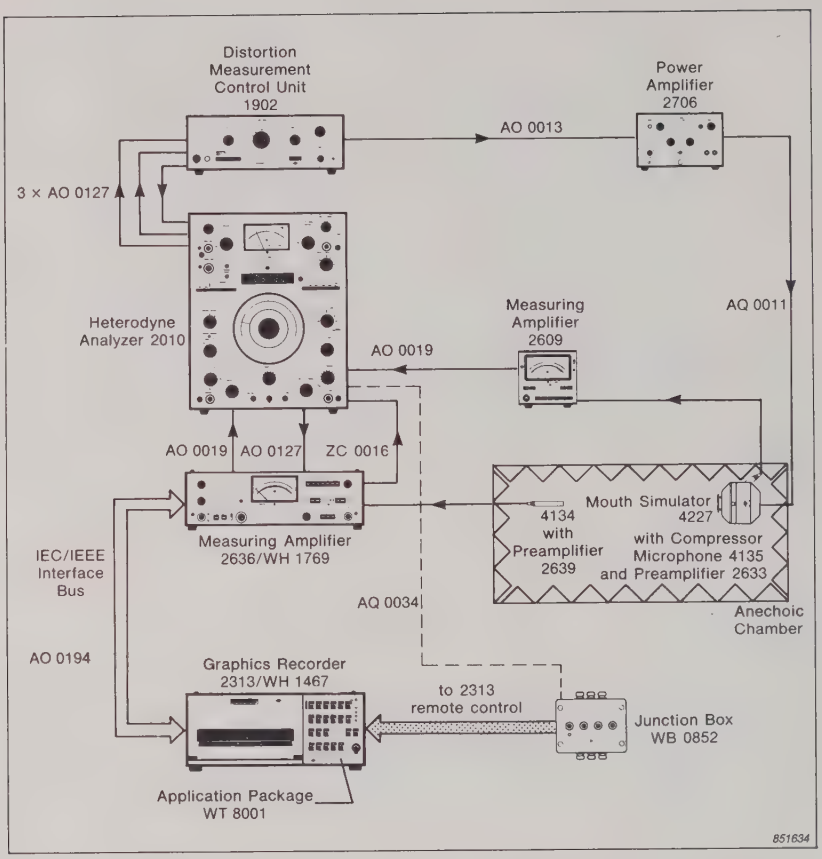


Fig. 3.8. Set-up for measuring harmonic distortion of the 4227

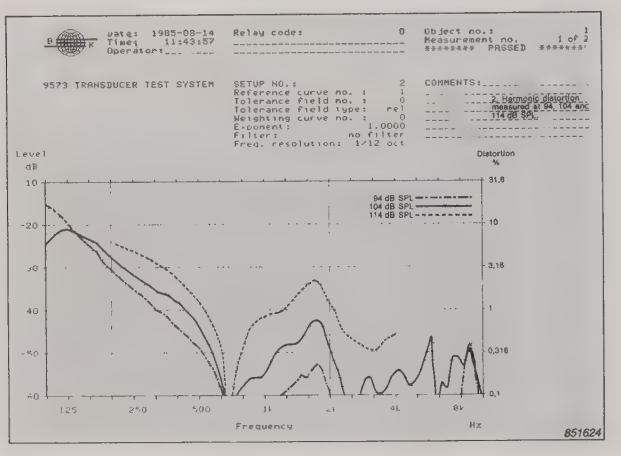


Fig. 3.9. 2nd. harmonic distortion measured at 94, 104 and 114 dB SPL with Microphone 4134 in Calibration Jig

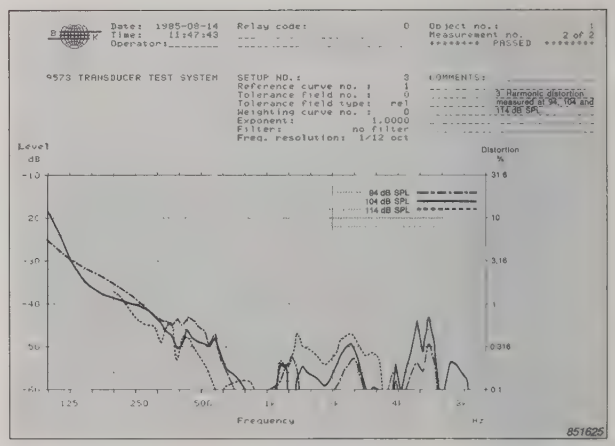


Fig. 3.10. 3rd. harmonic distortion measured at 94, 104 and 114 dB SPL with Microphone 4134 in Calibration Jig

3.2.4. Effect of Placing an Object in the Near Field

An electric generator can be described in terms of its voltage — current relationship for different load conditions. A voltage generator will ideally deliver the same voltage into all loads, whereas a current generator will deliver the same current into all loads. Increasing the obstacle to current flow (i.e. the resistance of the load) with a current generator will result in a higher output voltage. Similarly the Mouth Simulator, being an acoustic generator, can be characterized by the relationship between the sound pressure (analogous to voltage) and the volume velocity (the acoustic "current") at the mouth opening.

When a compressor microphone is being used, the sound pressure at the mouth opening will be independent of the acoustic load. If a compressor is not used the Mouth Simulator will deliver a constant volume velocity for a wide range of loads (obstacles). This causes the sound pressure at the mouth opening to increase (the so-called obstacle effect) when the object under test is positioned in front of the mouth opening.

Ideally the Mouth Simulator should simulate not only the outside geometry and the sound pressure distribution of a human mouth, but also its acoustic output impedance. This is however considered an almost impossible task as the acoustic impedance presented by a human mouth varies with both level and frequency. Therefore traditionally the well-defined, though low, generator impedance produced by a compressor microphone has been preferred. It has been argued that the uncompressed mouth might simulate somewhat better the impedance of the human mouth. However the obstacle effect is only significant for objects placed very close to the lip ring. Fig. 3.11 shows the influence of the obstacle effect on the frequency response and the loudness rating of the 4227 for 9 differently shaped commercial telephone handsets mounted in the Telephone Test Head Type 4905. The effect on the loudness rating is a shift of the mean value by 0,1 dB with a spread of $\pm$0,1 dB. The effect on the amplitude characteristics is similar; only in the range around 3 kHz is there any significant influence on the frequency response, but this is still of the same order as the effect of changing the temperature of the uncompressed Mouth Simulator a few degrees.

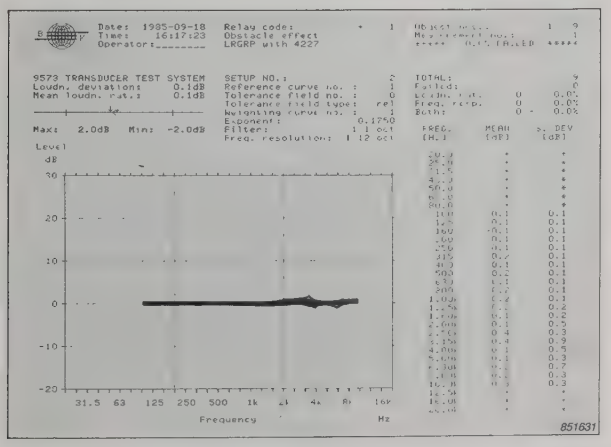


Fig. 3.11. "Obstacle effect" measured with 9 different common hand-sets, mounted in Telephone Test Head Type 4905 in the LRGRP position in an ordinary room. The three curves indicate the mean value and the mean value $\pm$ the standard deviation

3.3. TEMPERATURE EFFECTS

Moderate changes in temperature have only a minor effect on the output SPL and frequency response of the 4227. In the 20° C to 30° C temperature range, where the 4227 will normally find application, the maximum deviation is approximately 0,14 dB/C° over the entire frequency range. Fig. 3.12(a) and (b) show the amplitude deviations when the frequency responses at 20° C and 30° C are measured relative to a measurement at 25° C. If the 4227 is used over a wider temperature range, larger deviations can be expected, as indicated in Fig. 3.13.

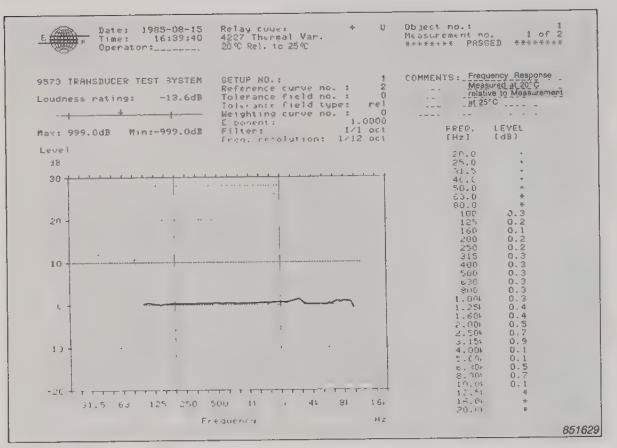


Fig. 3.12(a). Frequency response at 20° C relative to measurement at 25° C

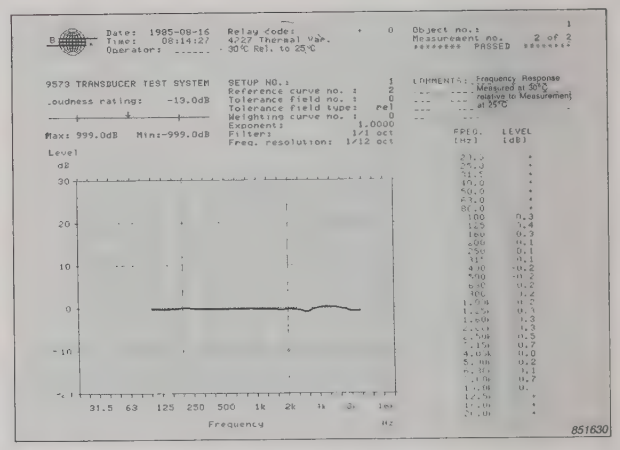


Fig. 3.12(b). Frequency response at 30° C relative to measurement at 25° C

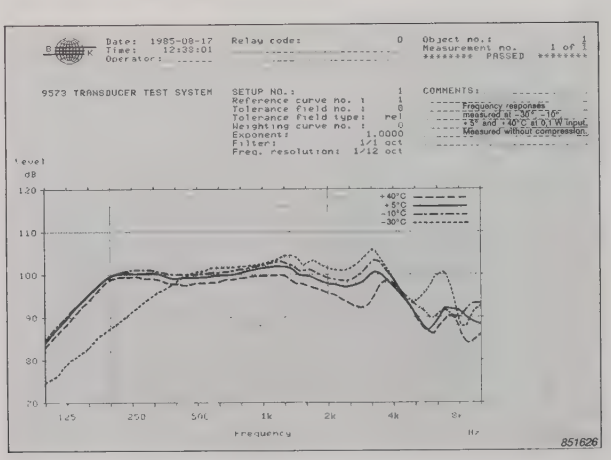


Fig. 3.13. Frequency responses measured at –30°, –10°, +5° and +40° C

3.4. CLOSED VOLUME CHARACTERISTICS

The closed volume frequency response of the 4227 was obtained using the set-up shown in Fig. 3.14 and with the mouth orifice closed.

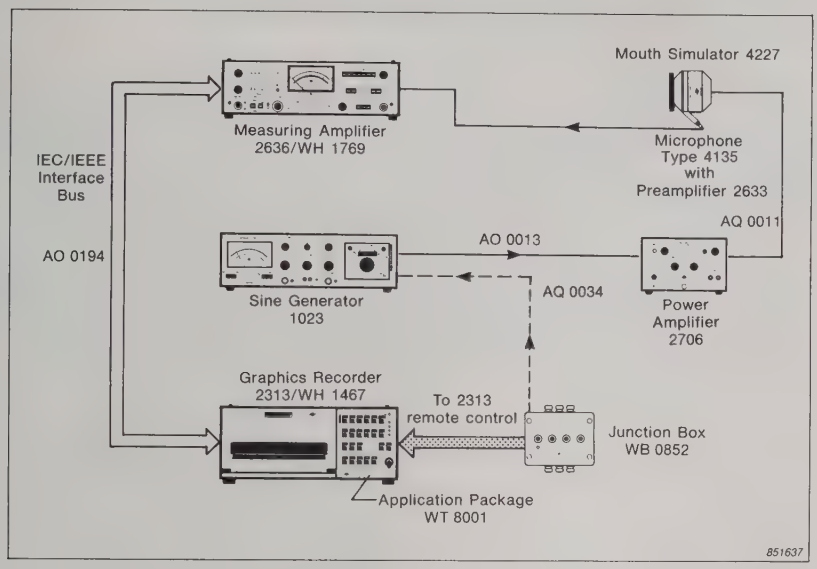


Fig. 3.14. Measuring arrangement used for recording the frequency response of the Mouth Simulator when the mouth orifice is closed

In Fig. 3.15 are given frequency response curves for 0,1 W (0,63 V), 1 W (2 V), 10 W (6,3 V) continuous operation and 50 W (14,1 V) pulsed operation (without compression) of the 4227 measured with a 1/4″ Microphone in the compressor microphone position.

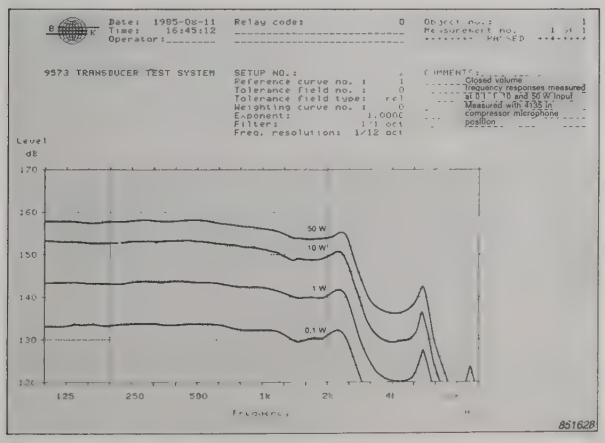


Fig. 3.15. Closed mouth frequency responses at 0,1, 1, 10 and 50 W input levels

3.5. VARIATION OF OUTPUT SPL WITH TIME AT HIGH LEVELS

When operated at power levels of several watts or more, the output SPL of the 4227 changes with time for a short period after the signal is applied due to heating of the loudspeaker coil. When a drive signal is applied, the output takes about 5 seconds to settle to a stable output SPL and decreases by a further 1 dB after 2 hours of continuous operation.

The short term effect is illustrated in Fig. 3.16 for different input power levels. When the 4227 is used for frequency sweeps at high power levels, the frequency response will be affected. The 4227 should therefore be calibrated under these conditions, as a calibration carried out at low power levels will lead to inaccuracies. This effect is negligible when operating at power levels less than 10 W.

When operating at high power levels, the 4227 is protected by a built-in overload protection circuit. Continuous operation is possible up to 10 W, while at input levels between 10 and 50 W pulsed operation can be employed, the pulse time being decreased with increased input (to approximately 2 s at 50 W). The effect of the overload protection circuit can also be seen in Fig. 3.16.

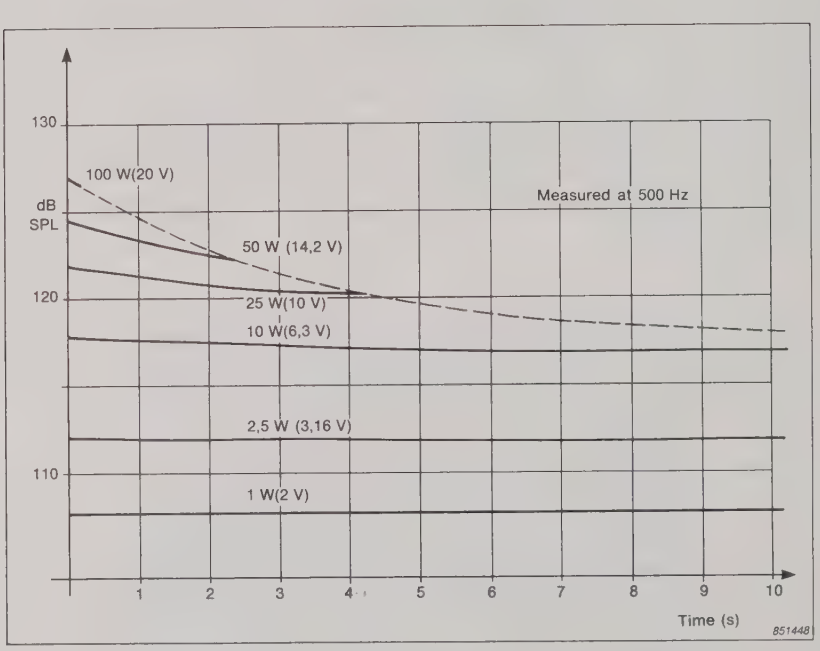


Fig. 3.16. Short term thermal influence on SPL and operating time as function of input power. Measured with Microphone in Calibration Jig

4. LITERATURE REFERENCES

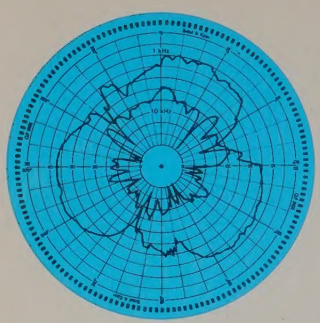
IEEE 269 – 1983: Method for Measuring Transmission Performance of Telephone Sets.

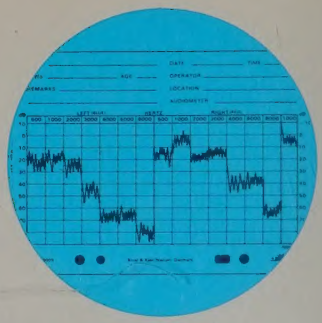
IEEE 661 – 1979: Standard Methods of Determining Objective Loudness Rating of Telephone Connections.

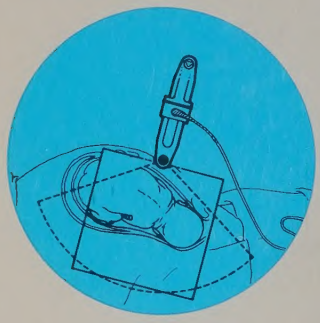
CCITT P.51: Artificial Voices, Artificial Mouths, Artificial Ears.

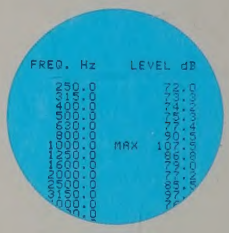
5. SERVICE AND REPAIR

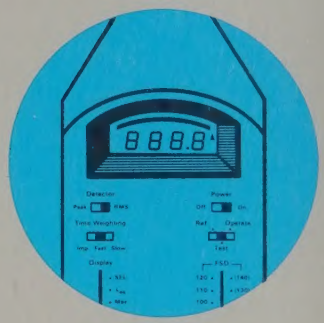
The 4227 is designed and constructed to provide the user with many years of reliable operation. However should a fault occur which impairs it's correct function, then it should be immediately disconnected from the drive source to prevent risk of further damage. For repair consult your local B&K service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

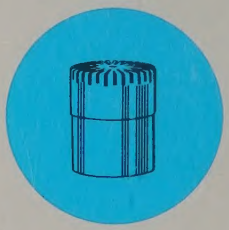


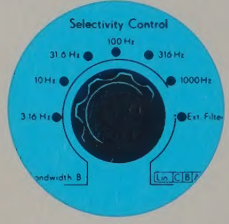


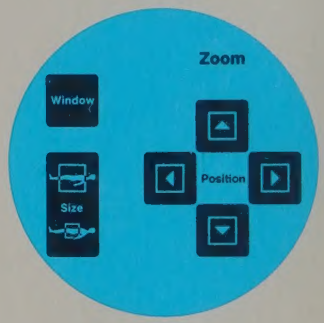


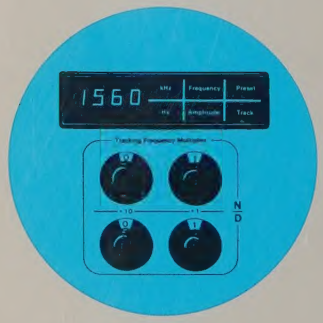


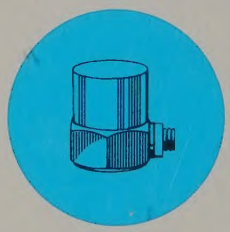


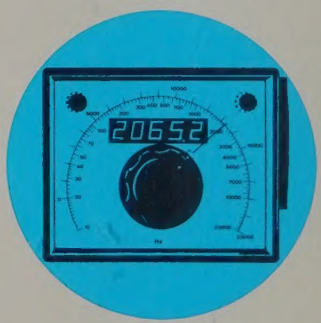


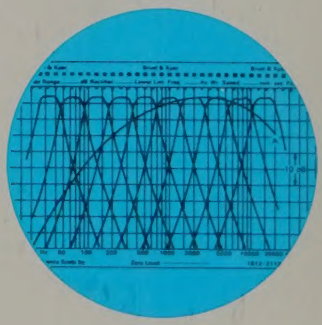












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